

THE *CITEMENE* SYSTEM, SOCIAL LEVELING MECHANISM, AND AGRARIAN CHANGES IN THE BEMBA VILLAGES OF NORTHERN ZAMBIA: AN OVERVIEW OF 23 YEARS OF “FIXED-POINT” RESEARCH

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ABSTRACT This article examines the social processes and mechanisms of agrarian changes based on a 23-year (1983–2006) case study of Bemba villages in northern Zambia. The Bemba have engaged in a unique shifting cultivation system called the “*citemene*” system in miombo woodlands. Villagers have sustained a *citemene* system that does not greatly exceed the amount required for subsistence. They have also maintained a leveling mechanism of distribution and consumption that promotes equity among the people, which could at times deter innovative changes. Beginning in the mid-1980s, semi-permanent maize cultivation with the use of chemical fertilizers quickly spread and expanded in the villages due to agricultural policies. However, in the mid-1990s, market liberalization led by the Structural Adjustment Program brought about a decline in maize production, and villagers returned to depend more on the *citemene* system. Around 2000, the Resettlement Project implemented by the government expelled villagers and *citemene* cultivation from parts of the miombo woodland. The villagers are currently searching for a new livelihood strategy. We classify these rapid changes in the villages into five periods and argue that the leveling mechanism could in fact promote agrarian change under some circumstances.

Key Words: Bemba; *Citemene* system; Agrarian change; Leveling mechanism; Zambia.

INTRODUCTION

The Bemba have developed a unique shifting cultivation called the *citemene* system in the vast miombo woodlands of northern Zambia (Richard, 1939; Allan, 1965; Kakeya & Sugiyama, 1985; Chidumayo, 1987; Stromgaard, 1988; Moore & Vaughan, 1994; Oyama, 1996, 2005). The Bemba are also known for the military strength of their once-powerful kingdom and their matrilineal society with its high divorce rate (Richard, 1940; Roberts, 1973).

Since 1983, we have conducted socio-ecological research in the Bemba villages in the territory of Chief Luchembe, Mpika District, in northern Zambia. In this paper, we analyze the processes and mechanisms of agrarian changes in these Bemba villages over the 23 years from 1983-2006 in relation to changes in economic and agricultural policies.

As our research base, we chose the village of Mulenga-Kapuli, which lies about 27 km west of the town of Mpika (Fig. 1). The village elder, Mulenga-Kapuli, founded this village in 1958, when he returned from working in the Copperbelt. Mulenga-Kapuli gathered his matri-kin, with his brothers and sisters at the core. The village of Mulenga-Kapuli has had close socio-economic relationships with the neighboring village of Ndona.

In 1983, Mulenga-Kapuli was small, with 13 households of which three were headed by females. Ndona had 30 households, of which ten were female-headed. Most villagers had experienced life in the city, but they led a subsistence life with strong reliance on the *citemene* system. The basic unit of production was the household, and the level of production never greatly exceeded what was necessary for self sufficiency. The villagers maintained a distribution and consumption mechanism that promoted social leveling, while avoiding a concentration of goods. Although 1/4 to 1/3 of the households in the two villages were headed by females, there was little economic disparity among the households (Kakeya & Sugiyama, 1985; Sugiyama, 1987.)



Fig. 1. Location of Mulenga-Kapuli village.

From about 1986, hybrid maize production using chemical fertilizers rapidly spread throughout the study area. We refer to maize production conducted in semi-permanent fields as *faamu* cultivation, according to the Bemba nomenclature. *Faamu* fields were prepared by felling and uprooting trees. By the mid-1990s, most villagers had begun to build a stable system wherein *citemene* cultivation for subsistence coexisted with *faamu* cultivation for cash crops. However, from the mid-1990s, the national economic policy shifted strongly toward market liberalization, and *faamu* cultivation ceased to be viable in the outlying rural areas. Moreover, the government Resettlement Project, which focused on the resettlement of large-scale commercial farmers, had reached full implementation near the villages in 2000. Under these circumstances, the people held firmly to *citemene* cultivation as they engaged in trial and error, seeking better opportunities for cash income. These agrarian changes over the past 20 years

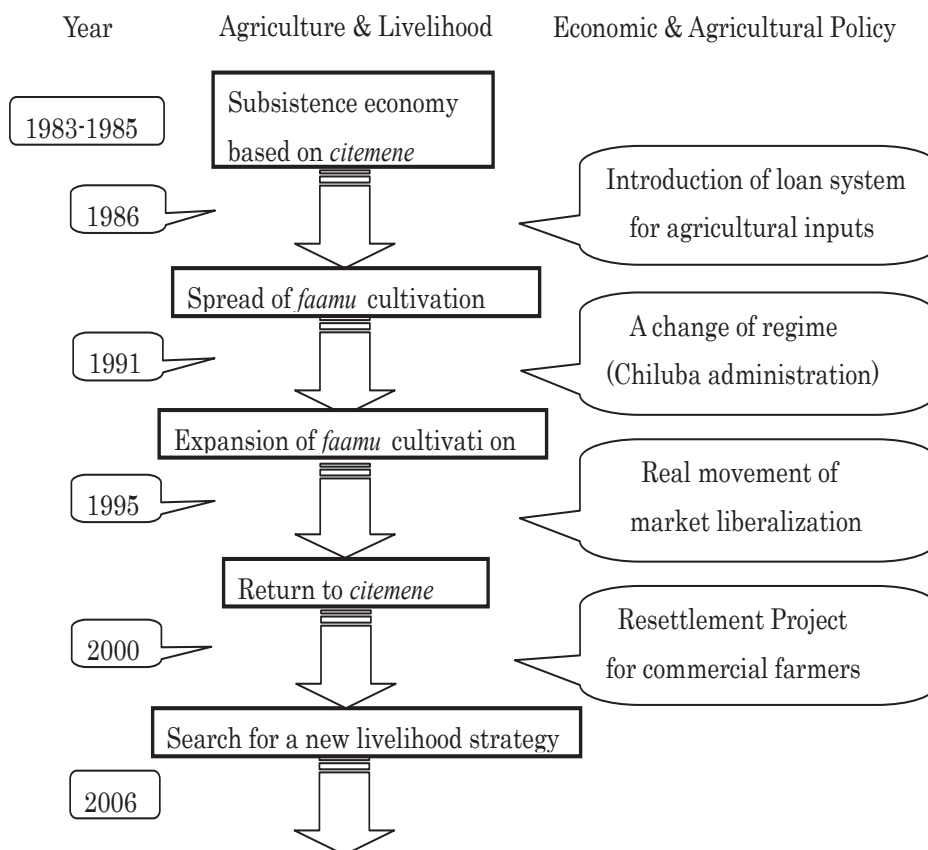


Fig. 2. Five periods of agrarian changes in the villages since 1983.

can be classified into five periods: 1) subsistence economy based on *citemene* cultivation, 2) spread of *faamu* cultivation, 3) expansion of *faamu* cultivation, 4) return to *citemene*, and 5) search for a new livelihood strategy (Fig. 2). We discuss these five periods, their characteristics, and mechanisms of change in the following sections.

SUBSISTENCE ECONOMY BASED ON *CITEMENE* CULTIVATION

We refer to the period prior to 1985 as the period of subsistence economy based on *citemene* cultivation. During this period, the villagers lived on crops produced by *citemene* cultivation as well as game meat and other wild food items hunted and gathered in the woodlands. They maintained self sufficiency while earning cash through peddling and selling finger millet beer that they had prepared themselves.

Citemene involves characteristic cultivation and crop rotation methods. The year is clearly divided into two seasons: a dry season from May to October and a rainy season from November to April. At the beginning of the dry season, men go into the woodlands and climb trees to cut off branches in large tree-cutting areas. After these branches have dried adequately, women carry and pile them in the center of the cutting area. At the onset of the rainy season, the wood pile is set on fire, and when the fires have extinguished, a field emerges. In the first year, the villagers plant finger millet and cassava, their main food crops. Finger millet is harvested from May to June. During the next 3 years, the field is continuously planted in a rotation of crops, such as groundnuts and beans, and after this time, the field is abandoned and left fallow. *Citemene* fields range from 0.2 to 0.7 ha according to the household composition; the average area measured during our study period was approximately 0.45 ha. The tree-cutting area is about seven times larger than the *citemene* field. Usually households headed by middle-aged and young men open larger *citemene* fields than households headed by elderly men and female divorcees.

The division of labor was clearly demarcated in such a livelihood system. Men engaged only in branch cutting during *citemene* preparation and in the sowing of finger millet during the agricultural activities. Men also obtained animal protein through hunting, while young and middle-aged men in particular earned cash through peddling. To acquire cash, the men brought surplus finger millet to the Bangweulu swamp area by bicycle, exchanged it for dried fish, and then sold the fish to villages along the road. Women played a significant role in attaining self sufficiency by engaging in most of the *citemene* agricultural work and gathering wild food items. Male-headed households were able to procure labor for branch cutting to establish *citemene* fields and for hunting, as well as cash through some peddling, whereas female-headed households were deprived of these opportunities. This led to economic disparity among households with different constituents. However, such disparity was leveled through intra-village sharing of *citemene* produce and the system of consumption.

Female household heads frequently made and sold finger millet beer. The cash earned was used for buying dried fish for protein intake and for employing male workers from other households to cut branches for the *citemene* fields. Female household heads also provided beer to fellow villagers who were cutting branches for *citemene*; these occasions sometimes developed into parties for the entire village. It was thus possible for female-headed households to maintain a stable livelihood, as long as labor for cutting branches was secured. Men who earned some cash through peddling would also buy beer for the other villagers upon their demand. Thus, the surplus finger millet from the households of younger men was turned into cash by selling fish and then flowed into the female-headed households through the purchase of beer made by the women; this purchase of beer, in turn, supported *citemene* production in female-headed households. Wives in households with larger *citemene* fields would frequently make beer for free communal drinking to entertain others. The brewing and sale of finger millet beer was the linchpin in the system of leveling disparity among the households in terms of *citemene* produce and cash income. In the village society of the Bemba, an important social ethic is that the “haves” must share what they have with the “have-nots.” Those who do not follow this ethic are severely criticized by fellow villagers. This ethic was reinforced by fear of sorcery derived from envy against the wealthy and enmity against those who refused to share. Such a leveling mechanism worked to control individual accumulation of goods and wealth and eventually restricted change in the village.

SPREAD OF *FAAMU* CULTIVATION (1986–1990)

Faamu cultivation spread between 1986 and 1990. During this period, the leveling mechanism of the village worked to enhance change rather than to restrict it (Kakeya & Sugiyama, 1987). The *faamu* spread can be described as follows. In the villages of Mulenga-Kapuli and Ndona, experimental maize cultivation began around 1982 by three pioneers who used chemical fertilizers that they had procured themselves. The other villagers observed the three men’s activities and results through daily dealings with them. Within several years, the villagers saw that it was profitable to cultivate hybrid maize in semi-permanent fields. Around this time, external situations also changed dramatically, including the start of surveying and road construction for a state farm that encompassed the miombo woodlands near the villages, a rapid rise in commodity prices due to inflation, and the introduction of loans for chemical fertilizers and hybrid maize seeds. In the villages of Mulenga-Kapuli and Ndona, several young and middle-aged men acquired loans and started *faamu*. The timing coincided with the influx of former city dwellers, who bought soap and clothes with their retirement money to reward villagers for working to cultivate their large *faamu* fields. Such action stimulated the wage labor system necessary for *faamu* cultivation and exchange of cash and goods. The men who used loans to begin *faamu* also began frequently hiring wage labor. Thus, the *faamu* cultivated by

pioneers quickly spread, propelled by young and middle-aged villagers and retirees from the cities. However, the same process also spread economic disparity between households with male labor and those without.

As the young and able men busied themselves cultivating *faamu* for their own households, a general shortage and resultant rise in wages for male labor in the village ensued. It became hard for female household heads to find men to cut branches for *citemene*. Background inflation drove down the sales of finger millet beer, formerly the main cash source for women, and the intra-village cash flow ceased to function. Instead of cultivating their own *faamu*, female household heads became laborers for large *faamu* and were paid in cash or given maize and other foodstuffs. Consequently, economic disparity began to increase between male-headed households and female-headed households (Sugiyama, 1992).

EXPANSION OF *FAAMU* CULTIVATION (1991–1994)

However, these conditions did not last. After 1991, *faamu* cultivation was practiced by almost all households, including those headed by women. We call this period between 1991 and 1994 the period of *faamu* expansion. Since one female-headed household had introduced a new method of brewing finger millet beer using yeast and sugar, the intra-village cash flow and the leveling mechanism was reactivated after being defunct for some time. The beer made by the new method required much less processing and fewer ingredients and incurred a higher profit. By frequently making and selling this beer, the female household heads could earn enough cash to employ men from other households. These women also employed men, especially young single men, who would drink “on credit” and pay for the beer in labor by cultivating *faamu* fields for the female-headed households; thus, these households were finally able to own sizable *faamu* fields. The women who sold this beer actively were household heads of the younger generation. These women would join forces with older female household heads, who were often their mothers, to successfully secure not only food for their own household consumption but also labor for cultivating their mothers’ household *faamu*. As a result, possibly all households in the village could then engage in *faamu* cultivation. The two-tiered strategy became commonplace, whereby self sufficiency was secured through *citemene* cultivation, and cash income could be gained through *faamu* cultivation (Oyama & Takamura, 2001).

Faamu cultivation was supported by protective policies toward farmers, including government subsidies. The inputs necessary for *faamu* cultivation were obtained by simply registering for a loan. Trucks sent from the fertilizer company collected the produce, and the produce price was nationally set; thus, *faamu* cultivation was a very profitable way of earning cash income for farmers in the remote area of the Northern Province.

RETURN TO *CITEMENE* (1995–1999)

With the regime change in 1991 from President Kaunda to President Chiluba, the International Monetary Fund (IMF)-led Structural Adjustment Program was wholly embraced to promote market economy principles and market liberalization. Financial support for the inputs needed for *faamu* cultivation was gradually phased out, and policies shifted to fewer and fewer price supports for maize. Agricultural produce distribution was completely deregulated in 1997, and *faamu* cultivation in the outlying area of the Northern Province became difficult and unprofitable.

We call this period after 1995, when policy shifts shook the basis of *faamu* cultivation, the period of return to *citemene*. Villagers in the study area began to try new and different activities to earn cash. The responses of the villages were diverse according to their location and the conditions of the miombo woodlands surrounding them. The villagers who were close to towns with deteriorated woodlands began to make charcoal to earn cash. Some villages relocated in search of previously unused miombo woodland for larger *citemene* fields of higher productivity. From such villages, surplus *citemene* produce such as finger millet was transported to and sold in markets during the rainy season when produce prices rose. Market liberalization had created more seasonal changes in the produce price. Such changes were also made possible by the “heritage” of the period of *faamu* expansion when produce sales became a commonplace means for earning cash, and many households came to own bicycles.

Raising outdoor free-range pigs became popular in the village of Mulenga-Kapuli. In 1994, one household headed by a middle-aged man began to keep pigs, which were bought from his wife’s natal village. After 6 months, another middle-aged man bought some pigs from another village. These pigs multiplied, and some were slaughtered, with the meat exchanged for *faamu* labor. Some pigs were also exchanged for maize. Gradually, more opportunities arose for obtaining pigs in exchange for labor or goats, which made it possible for households without maize or cash to raise pigs of their own. Many villagers started to concentrate their labor on pig farming and abandoned *faamu* cultivation altogether. After 1997, households in Mulenga-Kapuli mostly pursued a double-tiered livelihood strategy of securing self sufficiency through *citemene* cultivation and pig farming for cash.

This system, however, did not last long. By the middle of 1998, almost all households had abandoned pig farming. This abandonment was partly due to the serious food shortage of 1998, when erratic rainfall caused crop failures in maize and finger millet across large areas of the Mpika District. Villagers of Mulenga-Kapuli tried to cope with the situation by relying on cassava that they had planted in the *citemene*. However, this was not possible in *citemene* near the village, where the free-ranging pigs had destroyed the cassava. This destruction caused negative feelings among villagers towards the free-range pig system. Moreover, Chief Luchembe was concerned that pigs could contaminate the

water supply, thereby spreading waterborne infections. He thus banned outdoor free-ranging pigs altogether; consequently, most villagers gave up pig farming. The pigs that were kept in the free-ranging system were eventually removed from the village, either through butchering during the rainy season or through exchange for goats or food in other villages.

The abandonment of pig farming deprived villagers of a major source of income, increasing their dependency on *citemene* cultivation. Most households re-evaluated the importance of *citemene* cultivation, increasing their acreage compared to that during the *faamu* period. Villagers adopted a livelihood strategy in which *citemene* products served on one hand as subsistence crops and on the other hand as cash crops for sources of income as market prices increased. The villagers thus responded to market liberalization of agricultural produce.

SEARCH FOR A NEW LIVELIHOOD STRATEGY (2000–2006)

The return to *citemene* enabled the villagers of Mulenga-Kapuli to balance subsistence and cash earning. However, the ecological basis for such a response was undermined by the government's Resettlement Project (following the former state farm plan) for large-scale commercial farmers. The project has been developed near the villages since 1994 and has excluded villagers from parts of the miombo woodland that they had historically used extensively (Oyama, 1996). Desirable areas that the villagers had intended to open as *citemene* fields were incorporated into the resettlement scheme. Nevertheless, until 1999, use of the project land by villagers was tolerated, as the division of land and subsequent immigration had not yet occurred. By 2000, this use was no longer possible. Through their chief, the villagers petitioned the Zambian Government to reconsider the resettlement project, including the movement of the project boundaries. However, this request was denied.

People were compelled to open miombo woodlands near the village that had had insufficient fallow periods. In the neighboring village of Ndona, some people migrated to areas distant from the main road, where the recovery of miombo woodland was better. The people of Mulenga-Kapuli chose to stay, continuing *citemene* cultivation in nearby miombo woodlands as much as possible. Villagers who realized that their dependence on *citemene* would not stabilize their livelihood looked for farming methods to combine with *citemene* cultivation. As the villagers had generally viewed loan systems as unreliable and chemical fertilizers as something they had to purchase themselves, they considered the importance of indigenous farming methods that required no fertilizer inputs.

The basis for such farming methods was the *fundikila* method of enhancing soil fertility. At the end of the rainy season, farmers bury grass in the soil, forming large semi-cylindrical ridges on which sweet potatoes or beans are cultivated. By the next rainfall following a dry season, the ridges are flattened,

and groundnuts and maize are planted. From the third year onwards, narrow ridges are formed, on which legumes are planted, sometimes in combination with maize. *Fundikila* thus involves the decomposition of plant residues in the first year of the process, increasing soil fertility. Another method, without the *fundikila* process, is also used. Narrow ridges are formed in the beginning of the rainy season, into which grasses are buried and crops such as legumes are planted. Such farming methods are collectively called *ibala*.

Villagers are thus applying farming methods that do not require fertilizers, constantly altering the timings and types of crops to match the current situation. Households including young and middle-aged men may purchase fertilizers with cash obtained through the sales of legumes and dried fish. They can thereby restart maize cultivation with the input of fertilizers. Moreover, they are able to employ female household heads and unmarried men in exchange for cash, dried fish, or meat and can expand their acreage. Such households are gradually shifting their livelihood focus from *citemene* to *ibala*. Female-headed households, on the other hand, are centered on *citemene* cultivation. They obtain their meager cash income by farm work for resettlement-scheme immigrants or for villagers expanding their *ibala* acreage. These various responses are resulting in a disparity in acreage among households. At the same time the sharing of cash, fertilizer, and food is maintained through employment and gift exchanges among villagers. In March 2006, food was sufficient in the village even though this was the pre-harvest season.

Villagers have been seeking ways to stabilize their cash income. One such means is in the way agricultural produce is sold. Young and unmarried men are involved in this enterprise. They transfer bulk finger millet to the Tanzanian border and earn a large profit by taking advantage of price differences in agricultural produce between Zambia and Tanzania. Some female household heads have sought efficient cash income by consigning their sales of agricultural produce to young, unmarried men. Another means is by raising pigs and goats in roofed pens, earning large profits from their sales. Around 2000, this activity was limited to male households with financial capacity. In 2006, however, a group of women without financial capacity began raising pigs in roofed pens. Part of the cash earned through the sales of pigs will be directed to the purchase of fertilizer, with the aim of increasing yields from *ibala* fields.

With the spread of economic liberalization, villagers attempted to stabilize their livelihood by returning to *citemene* cultivation. Their attempts, however, were hampered by the resettlement project. Villagers then enlarged their acreage of indigenous *ibala* cultivation. In addition, some villagers have also undertaken cultivation requiring fertilizers, as well as livestock husbandry, as they search for a new livelihood strategy. The Bemba livelihood ethic rests on the sharing principle and is oriented towards food self sufficiency. However, current issues are the increasing disparities in acreage and incomes among households.

CONCLUSION

As summarized above, village livelihoods have rapidly changed in response to policy shifts. What is important here is that the villagers have firmly held onto *citemene* cultivation while experimenting with unique responses to the external economy. As apparent in the history of the spread of *faamu* cultivation in female-headed households or in the popularization of pig farming, economic disparity among the households has never followed a rise in new crops or animal husbandry. This balance exemplifies the distinct logic and dynamism of Bemba village society, which has a built-in leveling mechanism. The leveling mechanism has worked to control excessive economic activity by certain individuals in normal times, in effect restricting change in the villages. However, if conditions encourage the interaction of external and internal factors, the leveling mechanism may also work to promote more rapid responses, giving the Bemba village the potential for great change.

The opportune reactions of the Bemba to external factors are not new, but rather a reflection of the basic characteristics of their society. Moore and Vaughan (1994) pointed out that the Bemba, when faced with various changes in external situations, have always centered their identity on the *citemene* system and have reinforced it in their flexible responses to the changes. This flexible response does not work directly to change the village, because the villagers have a very strong orientation toward self sufficiency and because the sharing and consumption mechanisms that support this orientation have always been maintained.

Such livelihood strategies based on principles of “sharing” embedded in social relationships, as well as a strong orientation toward self sufficiency, have been noted as common characteristics among many other peasant societies in Africa. In his research on developments in maize cultivation in the Luapula Region adjacent to the Mpika District, Kokwe (1997) described a process similar to our observations of Bemba society. Further, in an analysis of the development of and change in rural life in a Tonga village in southern Zambia, Araki (2001) showed that a sharing ideology was maintained, functioning within a broad social network encompassing kinship and residential proximity, despite conflicts among persons with different interests.

Hyden (1980) conceptualized the above characteristics as an “economy of affection” in his depiction of peasantry uncaptured by the state. As Berry (1993) and others noted, this was also a basic strategy for survival under unstable political and economic situations, a characteristic often associated with the conservativeness of African peasants and the stagnation of African rural economies. Much to the contrary, our analysis of the Bemba case shows that villagers actively negotiate between the external cash economy and their household economy. Moreover, we should note that leveling mechanism based on the sharing principle could provide a driving force behind significant social change. It allows changes to occur in ways that are already familiar to the people, under the irreversible spread of globalization and liberalization.

In the territory of Chief Luchembe, there is another plan for agricultural development under the auspices of foreign companies, including those based in South Africa. The crisis of ecological sustainability surrounding *citemene* cultivation will manifest as a wide-ranging issue that transcends the village of Mulenga-Kapuli.

How will the villagers manage the issues they face in this new era and under an increasingly less amenable environment? Field researchers must carefully observe and actively search for the possibilities waiting to be revealed from within the unique context of Bemba socio-ecological dynamism and the knowledge accumulated from the experiences of the Bemba people.

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REFERENCES

- Allan, W. 1965. *The African Husbandman*. Oliver and Boyd, London.
- Araki, M. 2001. Outside development interventions: People's daily actions among the Plateau Tonga of Zambia. *African Study Monographs*, 22(4): 195-208.
- Berry, S. 1993. *No Condition is Permanent: The Social Dynamics of Agrarian Change in Sub-Saharan Africa*. University of Wisconsin Press, Madison.
- Chidumayo, E.N. 1987. A shifting cultivation land use system under population pressure in Zambia. *Agroforestry Systems*, 5: 15-25.
- Hyden, G. 1980 *Beyond Ujamaa in Tanzania: Underdevelopment and an Uncaptured Peasantry*. University of California Press, Berkeley.
- Kakeya, M. & Y. Sugiyama 1985. *Citemene*, finger millet and Bemba culture: A socio-ecological study of slash-and-burn cultivation in northeastern Zambia. *African Study Monographs*, Supplementary Issue, 4: 1-24.
- & ——— 1987. Agricultural changes and its mechanism in the Bemba villages of northeastern Zambia. *African Study Monographs*, Supplementary Issue, 6: 1-13.
- Kokwe, G.M. 1997. *Maize, Markets and Livelihoods: State Intervention and Agrarian Change in Luapula Province, Zambia, 1950-1995*, Interkont Books 9. Institute of Development Studies, University of Helsinki, Helsinki.
- Moore, R.M., & M. Vaughan 1994. *Cutting Down Trees: Gender, Nutrition, and Agricultural Change in the Northern Province of Zambia, 1890-1990*. James Curry, London.
- Oyama, S. 1996. Regeneration process of the miombo woodland at abandoned *Citemene* fields of northern Zambia. *African Study Monographs*, 17(3): 101-116.
- 2005. Ecological knowledge of site selection and tree-cutting methods of Bemba shifting cultivators in northern Zambia. *TROPICS*, 14(4): 309-321.
- Oyama, S. & T.Y. Takamura 2001. Agrarian changes and coping strategies of Bemba shifting cultivators in northern Zambia in the mid-1990's. *Japanese Journal of Tropical Agriculture*, 45(2): 84-97.
- Richard, A.I. 1939. *Land, Labour and Diet in Northern Rhodesia: An Economic Study of the Bemba Tribe*. Oxford University Press, London.
- 1940. *Bemba Marriage and Present Economic Conditions*. Rhodes-Livingston

Paper, No.4, Livingston.

Roberts, A.D. 1973. *A History of the Bemba: Political Growth and Change in North Eastern Zambia before 1900*. Oxford University Press, London.

Stromgaard, P. 1988. Soil and vegetation changes under shifting cultivation in the miombo of east Africa. *Geografiska Annaler*, 70B: 363-374.

Sugiyama, Y. 1987. Maintaining a life of subsistence in the Bemba village of northeastern Zambia. *African Study Monographs*, Supplementary Issue, 6: 15-32.

——— 1992. The development of maize cultivation and changes in the village life of the Bemba of northern Zambia. *Senri Ethnological Studies*, 31: 173-201.

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